bons **520**, **534** extending beyond the ends of their horizontal strings with anode of one horizontal string connected to the cathode of the neighboring string in the series connection. Thus, for the overall solar panel **550**, the output current will be proportional to the number N of cells **552** in each string **554**, and the output voltage will be equal to the output voltage of a single string **554** times the number M of strings **554** wired in series. External electrical connections **558**, **560** may be made to different ones of the ribbons **520**, **534** on the opposed ends of the series and output the solar power of the solar panel **550** to the electrical power network. With the same arrangements of PV cells as shown in FIGS. **9** and **26**, the output currents and voltages for the second and third embodiments will be the same.

[0105] In the parallel connections of FIG. **26**, the binning involves matching or nearly matching the open circuit voltages V_{OC} for each solar cell **552** in each of the strings **554**. Matching of open circuit voltage between the strings **554** is not required.

[0106] The first embodiment can be readily adapted to the parallel connections of FIG. **24**. Referring to FIG. **5**, the parallel connections may be effected by aligning the P bus bars **314** of all the donor wafers **244** in the horizontal string with a single first long ribbon **334** and by aligning the N^+ bus bars **316** on all these donor wafers **244** with a second long ribbon **334**. The ribbons of opposite types are connected in series between the horizontal strings.

[0107] It will be understood by those skilled in the art that the foregoing descriptions are for illustrative purposes only. A number of modifications to the above manufacturing processes are possible within the scope of the present invention, such as the following.

[0108] The adhesion layers used to laminate the PV cells to the backside substrate or the frontside glass may be a material other than ethyl vinyl acetate (EVA).

[0109] The backside substrate may comprise Tedlar, a plastic material manufactured by DuPont. The backside substrate may comprise a material other than Tedlar, with the necessary structural characteristics to support the PV cell array in the solar panel. For example, the backside substrate may be glass. Alternatively, the backside substrate may be a polymerizing material, which is flowed onto the epitaxial sides of the donor wafers and then hardened to form a support layer.

[0110] The frontside glass layer may comprise, instead of glass, a clear plastic material or other transparent material.

[0111] The attachment of the ribbons to the PV cell contacts (bus bars) may be accomplished other than imbedding the ribbons in the adhesive.

[0112] Various methods for etching through the passivation layers are possible, such as wet etching, Reactive Ion Etching (RIE), or laser ablation. In the RIE process, the plasma would contain chemical species (ions and radicals) which react with the passivation layer. All these etching methods are well known to those skilled in the art and are not part of the present invention.

[0113] Other metals than aluminum and silver may be used for the interconnects and contacts.

[0114] The P-type and N-type doping may be interchanged.

[0115] The improved solar panel manufacturing process of the present invention affords improved yields through reduced breakage of PV cells during processing due to the mechanical support for the PV cells afforded by lamination to either the backside substrate or frontside glass layer. Materials costs are also substantially reduced through the use of donor wafers which may be recycled through multiple PV cell fabrication processes. The use of epitaxial deposition to form the PV cell layers leads to improved control over doping profiles and sharper junctions, leading to improved PV cell efficiency through reduced electron-hole recombination.

[0116] The invention allows robust handling of the PV cell formed in the epitaxial layer as it is transferred from the donor wafer to the mounting substrate since it is never left free-standing.

[0117] The invention allows the epitaxial layers to be formed at high temperatures and in sizes commonly found in the semiconductor industry while the remaining processing may be performed at lower temperatures and on large size panels promoting high throughput.

What is claimed is:

1. A solar panel manufacturing method, comprising a process for forming a multiplicity of photovoltaic (PV) cells, the process comprising the steps of:

forming separation layers on a multiplicity of donor wafers;

depositing on each of the separation layers a plurality of silicon layers including an n-type silicon layer, a p-type silicon layer, and contacts to at least some of the n-type and p-type silicon layers to form a multiplicity partially completed PV cells in the donor wafers, and

a combining step including tabbing at least some of the contacts on the multiplicity of partially completed PV cells and assembling the partially completed PV cells to form a string and bonding the string to a common first substrate using a first adhesion layer such that the silicon layers are disposed between the donor wafers and the first substrate.

2. The method as in claim **1**, further including separating across the separation layers the donor wafers from the silicon layers and contacts bonded to the first substrate.

3. The method as in claim **2**, wherein the separating step comprises the steps of:

clamping the donor wafers on sides opposite the n-type and p-type silicon layers with a wafer clamping assembly; and

applying a separating force between said wafer clamping assembly and the common substrate, the separating force inducing separation of the donor wafers from the n-type and p-type silicon layers at said separation layers.

4. The method as in claim **2**, further comprising the step of:

a completing step of forming remaining portions of the PV cells on those of the n-type and p-type silicon layers uncovered by the separating step, thereby completing the PV cells.

5. The method as in claim **1**, wherein each of the partially developed PV cells includes passivation and antireflection coatings on a textured surface to form a front side of the PV cell.

6. The method as in claim **5**, wherein the common first substrate is a transparent substrate and the first adhesion layer at the completion of processing is transparent.

7. The method as in claim **6**, wherein the first adhesion layer comprises ethyl vinyl acetate.

8. The method as in claim **4**, wherein the completing step includes second depositing steps of depositing a second passivation layer over back sides of the partially completed PV cells and depositing a metal layer over the second passivation layer and forming contacts of the metal layer to the silicon layers through the second passivation layer.